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UPM-Kymmene Corporation's pulp handling in ports

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Tämä opinnäytetyö tehtiin toimeksiantona UPM-Kymmene Oyj:lle. Työn taustana oli halu koota kokonaisvaltainen kuvaus satamakäsittelyssä käytetyistä prosesseista sellun osalta. Tämän lisäksi oli myös tietoja siitä että satamakäsittelyssä ja siihen liittyvissä kuljetustoiminnoissa tapahtuu sellupaalien erilaista vahingoittumista, mikä lisäsi kokonaisvaltaisen kuvauksen tarvetta.

Tätä taustaa vasten työn perimmäiseksi tavoitteeksi muodostuikin vahinkomäärien ja niiden syiden selvittäminen, analysointi ja raportointi. Tämän päätavoitteen ohella oli tarkoitus kartoittaa satamakäsittelyn prosesseja ja toimintatapoja yleiselläkin tasolla, jotta koko ketjua voidaan katsella tietynlaisena kokonaisuutena.
Työ rajoitettiin tarkasti koskemaan pelkästään satamissa ja laivoissa tapahtuvaa sellun käsittelyä. Tämä oli erittäin looginen valinta, koska koko sellun toimitusketjun tarkkailu tämän kokoluokan yrityksessä olisi antanut liian pinnallisen kuvan tutkittavasta ongelmasta. Toimitusketjuun kokonaisuutena liittyy myös paljon sellaisia asioita mihin ei tämän laajuisessa työssä kannata ottaa kantaa tai joihin ei voi vaikuttaa.

Työ toteutettiin syksyn 2013 ja kevään 2014 välisenä aikana. Pääasiallisina menetelminä käytettiin tekijän omaa havainnointia ja keskusteluja sellun käsittelyn kannalta avainasemassa olevien henkilöiden kanssa. Menetelmiin kuuluivat myös kvantitatiiviset ja kvalitatiiviset menetelmät sekä tilastoaineisto.

Työn tuloksena havaittiin sellun käsittelyssä olevan ongelmia kahden sataman osalta, joissa vakavuudeltaan kevyempiä ulkoisia vaurioita oli korkea määrä. Kokonaisuutena tuloksista näkyi kuitenkin että käsittely toteutettiin järkevästi ja tehokkaasti, koska vahinkoja oli yleisellä tasolla vähän, varsinkin ottaen huomioon käsittelyoperaatioiden korkea volyymi.

Asiasanat
logistiikka, paperiteollisuus, sellu, satamat, merikuljetus

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Abstract

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This Bachelor's thesis was written as a commission of UPM-Kymmene Corporation. UPM-Kymmene wanted to get a comprehensive description of their processes involving pulp handling in ports. There were also indications about pulp getting damaged during port handling and other similar transportation operations, which further suggested the need for a comprehensive evaluation.

As a reflection of this background, the main goal of the thesis formed around mapping, examining and analyzing the damage levels and their causes. Alongside this main objective it was agreed that an overall mapping of the port handling processes and procedures would be necessary to get a wider viewpoint on the pulp supply chain.
The thesis was tightly restricted to only deal with the pulp handling taking place in ports and vessels. This was done to ensure a thorough and in-depth report of the problems at hand. Furthermore this was only natural, since the whole pulp supply chain has many aspects which would not have been relevant or are outside the influence of both the company and the author of the thesis.

The thesis was carried out in the time period between autumn 2013 and spring 2014. The main methods used were personal observations and discussions with the key people in UPM's pulp supply chain. Besides this also qualitative and quantitative methods were used as well as statistical material.

The results showed high levels of minor external damage to the pulp bales in two specific ports. Despite this the overall level of damages was quite low considering the volume of the handling operations. The results indicated that as a whole the handling operations were conducted properly and efficiently.

Key words
logistics, paper industry, pulp, ports, marine transport

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1 Introduction

This thesis was done as an assignment for UPM-Kymmene Corporation, one of Finland's biggest companies and also one of the biggest paper companies in the world. The reason for this thesis was that UPM wanted to get a report showing a comprehensive picture of their logistical processes in terms of handling pulp bales and all the relevant operations that contribute to it. They had some prior knowledge of pulp bales becoming damaged at some point during the handling operations around ports in Europe, Asia and South America. This is why the main goal of the thesis was to examine how the bales are being handled along the way and what might be the reason for the various types of damage. Naturally with the global economy being what it is at the moment, this was a big point of interest in terms of the complete pulp supply chain and the bigger picture of UPM's value chain. Personally this was also one of the reasons why I found the subject really interesting and challenging. Moreover UPM, in my mind, is one of the more iconic and traditional industrial giants in Finland.

As I mentioned, the main objective was to analyze the handling operations and find reasons for the damaged pulp. To be more precise these handling operations mean how the pulp bales get to the port and how are they moved there. This means things like short-term storage in the port area, using forklifts and other machinery to move the bales around there for example. The key was to focus not as much on the technical aspects of the machinery but more to the way they were used and how. Other main points in examining the handling was the whole procedure of things being done at the quay or alongside the ship, such as loading/unloading, platforms or cranes being used.

The thesis was restricted quite clearly as to strongly emphasize the operations in ports and sea vessels there and not to focus on things like shipping routes or companies for example. I found this important since looking at the whole supply chain of a company this size would have been a herculean task. Naturally this restriction also enabled a more precise and in-depth focus in the things affecting the main research problem.

The most important methods being used in the thesis were by far: on-site observations and discussions with people involved in the pulp supply chain. The observation was

done at different ports in Finland where most of the UPM pulp was being handled. In Finland these locations were the port area alongside the UPM pulp mill in Pietarsaari and the main cargo port for whole Finland, port of Kotka-Hamina. Besides these observations I conversed and exchanged information with a number of UPM personnel working with the pulp transportation operations as well as personnel from port operators.
Qualitative and quantitative methods were used as well as. Last method used was analysis of statistical data.

1.1 Research problem and goals

The main research problem could be formed as a single question "Why do we have damaged pulp after transportation". This might be a little too simple, so the research problem is best described as a process of examining current methods of handling pulp and analyzing where, how and how often these pulp bales are damaged. So the main focus of the thesis is in finding the reasons for the damaged bales.

Other than answering the main research problem, this thesis was meant to also map out, list and examine the methods and procedures being used in the current pulp handling operations. The employer also wished to that this examination of the current pulp handling methods would create a complete and in-depth picture of everything what is happening during the handling operations, in the confines of the aforementioned restrictions of course. As a natural part of the overall examination of the handling process, some priority was also given to analyzing and creating numerical data about the amount of damaged pulp and the severity of it.

1.2 Research methods, reliability and validity

This thesis is mainly a case-study, with some aspects that can be thought of as action study. The research is done mainly by qualitative methods with some minor use of quantitative methods.
Most of the research material has been gathered by observation and interviews/discussions. The rest is gathered from written sources such as reports, textbooks, internet pages, using simple content analysis. The thesis also includes different

statistics about the handling, loading and unloading of pulp in ports. Some is this data is shown in charts in the text and others only as attachments

In quantitative research validity is used as a testing concept for determining if the thesis answers the posed questions or in other words have the right issues been researched. Similarly reliability as a concept is used to determine how repeatable and consistent the results of the research are. (Kananen 2011, 125-126.)
In qualitative research these same concepts are used but cannot be applied in the exact same terms due to the differences in the research methods. In qualitative research the concepts of reliability and validity are interpreted as credibility, transferability, dependability and confirmability. A further dilution of the concepts is common, leading to assessability and documentation, consistency of interpretation, informant's view of reliability and saturation.
Assessability is characterized as an examination of the used research methods and the transparency of the documentation. Consistency of interpretation as a concept examines the way the results are interpreted consistently to ensure it has been analyzed in accordance of the used methods and posed problems. Reliability of the informant's point of view can be seen as an extension of the consistency of interpretation, only from the other side of the research to ensure that the interpretations of results are valid. The concept of saturation is used to prevent repetition by limiting the number of cases to only those that contribute anything new. (Kananen 2011, 66-71.)

1.3 Research structure

The first chapter gives an overall introduction to the themes of the thesis, as well as gives a description of the research methods and tools used.
The second chapter aims to provide insight to some logistical concepts that have been used as a base of analysis on themes of thesis.
The third chapter gives details about the target company UPM as a whole, even though the main focus is in the key locations and facilities in terms of pulp production. This also includes the main ports being used in the pulp supply chain and their roles within the supply chain.

Chapter four aims to explain the different aspects of the logistical processes involved in the supply chain of pulp, starting from the equipment and continuing on to the different situations and locations where the pulp transportation and handling is done
Chapter five is a collection of all the relevant statistics from the damage control viewpoint. Most of this data is explained in charts besides text and the more comprehensive excel sheets containing the raw numbers will be present as attachments
Chapter six explains the main causes of damage found during the research, observation and analysis of the source material and port operations.
Chapter seven shows the analysis of the possible solutions to the problems detailed in chapter six.
Chapter eight gives an overview of the conclusions I reached based on the analyzed results.

1.4 Theoretical framework

The larger theoretical background is taken from supply chain management or SCM, with strong emphasis on materials handling. Also other theories within the field of logistics might be used if relevant.

Supply chain management is used as term to define and explain all the different phases and members within a given supply chain. This includes all the activities from the raw material stage to the end user as well as all the associated flows of information, money, goods etc. The idea is to find to most effective way of managing all the processes and flows of information in the given situation and field of business. (Murphy & Wood 2008, 34-35.)

Materials handling examines the short-distance movement of products or raw materials and the effect of these movements to the cost and value structure of the supply chain. (Murphy & Wood 2008, 23.) Materials handling explains how the unique physical properties and customary volumes or quantities affect the decisions about how and when the product is packaged and moved. (Murphy & Wood 2008, 107.)

Materials management can also be called planning and control or logistics management but in this case materials management is used. Materials management is a concept where a single department handles all the flows of material, all the way from raw materials, production through to the end user. The main idea of materials management is to coordinate all the materials flow through controlling and planning with the goal of maximizing resource usage but still keeping the required customer service level. (Arnold, Chapman & Clive 2008, 10-11.)

Time compression is another theory that should be mentioned, since it appears in the analysis frequently. This is normally understood as a concept of cutting non-value adding processes to reduce the total time a given business operation takes. This is particularly important since most of the times the value adding processes account only for 5 percent of the total time. (Beesley 2007, 73-76.)

2 Logistics

The concept of logistics as complete ecosystem affecting every phase between for example a manufacturer and a customer is fairly new one. Originally logistics was just thought of as a physical distribution network and many times the concept was applied just to be about getting the right product to the customer at the right time and place. Therefore it was usually just thought to be the problem of marketing or warehousing department or any other singular business unit.
Current thinking is a bit more evolved. Logistics is thought to impact all areas of business and also therefore every department has at least some kinds of responsibilities in regards to logistical processes. A good way to sum up would be to describe logistics as a combination of varied and possibly fragmented operations that form an important process to support the core business. (Sakki 2003, 23.)

It is also necessary to examine the two basic ways to approach logistics: systems approach and total cost approach. Generally speaking the systems approach sees logistical processes individually, whereas total cost approach considers the process to be a singular entirety. The systems approach wants the different functions of the firm to recognize their dependence on each other, so that for example a decision made by marketing does not cause problems to storage. The approach calls for each function to consider the implications of their decisions to other areas.
Total cost approach on the other hand sees the processes as one whole operation, taking into account how everything influences everything and as the name suggest, the main emphasis being on the total cost. This approach takes all the costs of relevant logistics operations into account simultaneously, with the aim of finding the lowest possible option cost-wise. This is achieved by creating cost trade-offs between different operations, meaning that if you raise the cost of operation X and lower the cost of operation Y, the actual cost of everything relevant combined might be lower. (Murphy & Wood 2008, 10-13.)

2.1 Supply chain management

To take a closer look at supply chain management, one must first clarify supply chain. The simplest way to explain supply chain is to define it as a group which includes everyone directly or indirectly involved in fulfilling a customer request. This means that a supply chain includes naturally supplier, manufacturer and customer, but also all the supporting operators like transporters and retailers. In addition to these operators all being involved in the physical distribution and production of the product, there's also a constant flow of all the other production factors like information and funds. (Chopra & Meindl 2004, 4-5.) Another way to define a supply chain would be as all the activities, operators and information flows needed in the transformation of goods from the raw material stage all the way to the end customer. (Murphy & Wood 2008, 34-35.)

Supply chain management is an even newer concept inside logistics. To put it simply supply chain management can be described as handling the managerial aspects of logistical operations of a given company. In a broader sense SCM is a theory that comprises all the management and planning of the operations in a supply chain structure including collaboration and coordination outside the company like for example with suppliers and third-party service providers. Another very useful definition for SCM is the SCOR-model (Supply-Chain Operations Reference) which is divided into five processes: Plan, Source, Make, Deliver, Return. This model is nice since it includes the often forgotten idea that supply chain management and logistics in general does not really end when the end user has the product in hand. Malfunctions, servicing and customer returns are also a part of the logistics process and need to be accounted for. (Murphy & Wood 2008, 35.)

2.2 Materials handling

Materials handling, like mentioned before, is all about how and when to physically handle the product. At first glance it might sound as the same as transportation, but materials handling deals specifically with short-movements of goods. A good example of materials handling would be the movement of a finished product from the production line or facility to the warehouse. (Murphy & Wood 2008, 107-109.)

In a way materials handling can be seen as a micro-level of logistics, since it takes account most of the same principles as logistics as a whole but only in a smaller and more specific real-world setting. Materials handling has a set of guiding principles, of which in this case the most relevant are: planning, standardization, unit load, space utilization and automation principles.

These principles are mostly quite straightforward, the planning principle just calls for a careful thinking of the needs, objectives and functionalities of the used methods. Standardization principle as the name would suggest, calls for standardization of the processes without limiting performance, modularity or flexibility.

Unit load and space utilization principles can be combined as a bigger principle which aims to maximize effectiveness in terms of utilization of space and material flow.

The automation principle is quite simple as well, the main goal is to maximize predictability, efficiency and consistency using mechanized or automated operations. (Murphy & Wood 2008, 129.)

2.3 Materials management

As mentioned materials management aims to maximize resource usage still providing a necessary level of customer service. This is done by having one department that handles all the materials flows throughout the whole supply chain. Materials management can cut total costs as much as 15 percent, thus adding value to the supply chain, possibly increasing profit by as much as 60 percent. By controlling supply, planning and controlling manufacturing and controlling physical distribution by combining the materials flows under one department the overall effectiveness of the business operation can be raised, thus providing added value. (Arnold et al. 2008, 10-17.)

2.4 Time compression

Time compression is not necessarily about being just fast. The bigger concept is to make correct tactical decisions with speed, enabling the completion of time-based objectives by way of having a strong and holistic supply chain structure. Cutting non-value-adding processes is paramount since these can account up to 95 percent of the total time used in business operations. Naturally this makes the remaining 5 percent of operations really key and increasing their efficiency can result in a dramatic value gain.

Time compression has seven key strategies: simplification, integration, standardization, concurrent working, variance control, automation and resource planning. Most of these are quite simple to understand. Simplification refers to removing unnecessary complexity from the processes, integration refers to increasing linkages between operations and improving the flow of information. Standardization refers to generalized processes, modules, components and protocols. Concurrent working means simply increasing the number of parallel operations. Variance control refers to avoiding quality or time-waste issues by having a high level of monitoring and problem detection. Automation refers simply to increasing the efficiency and effectiveness of processes by upgrades. Resource planning aims to avoid bottleneck and promote flexibility by planning and using the best SCM practices. (Beesley 2007, 73-77.)

In this study the logistics concepts are used as background to evaluate the handling portion of the whole supply chain. Furthermore emphasis is placed on the handling's effects on the other parts of the supply chain.

3 UPM-Kymmene Corporation

UPM-Kymmene Corporation is one of global leaders in the paper and forest products industry, with a market capitalization of 6,5 billion euros and about 10 billion euros in sales. In 2013 UPM had production facilities in 14 countries and sales presence in 63 countries all over the world and employed about 21 000 persons. (UPM 2014, 2.)

The main areas of business for UPM are in Europe, Americas and Asia. Finland is still the center of operations for UPM, with the group head office and significant production capacity located there. UPM employs over 8 000 persons in Finland in 27 production plants and other facilities as well as produces approximately 12 percent of Finland's yearly sea freight exports. (UPM 2014, 29-30.) One of the newer business areas, biofuels is also a good indication about UPM's focus in Finland, with a new biorefinery opening in Lappeenranta summer 2014. (UPM 2014, 7.)

This thesis focuses mainly on the key locations for UPM's pulp business. These locations are distributed mainly around Europe, with Finland, Germany and the Netherlands being the most important, at least in terms of this thesis.
Besides Europe, pulp operations are mainly based in Uruguay, especially in terms of production.

3.1 UPM pulp

UPM has pulp production facilities in Uruguay and Finland, with three mills in Finland and one in Uruguay. The mills have a combined yearly production of approximately 3,3 million tons, with about 2/3 produced in Finland and the rest in Uruguay.
Pulp is actually a surprisingly versatile product, since it can be used in everything ranging from paper production to fabrics and hygiene products. Also when used as nanocellulose it can be used as a food additive, component for medical, cosmetic and pharmaceutical products. Of course the main area of use is still the production of paper, cardboard and similar products.

3.1.1 Finland

UPM mills are distributed along the shoreline, as this is a natural choice for transportation reasons. Only one mill is located at the coastline, in Pietarsaari, in the northern part of the Gulf of Bothnia. The other two (Kymi, in Kuusankoski and Kaukas, in Lappeenranta) are located in Eastern Finland, close to the Russian border. This is a convenient location since Russia exports both raw materials and energy to Finland, and also since both mills have good connections to the nearby port of Kotka-Hamina. Combined these three mills employ around 700 persons and produce around 2,1 million tons of pulp, which as stated earlier is about two-thirds of the total yearly capacity. From this about 36 % goes to export.

3.1.2 Uruguay

UPM has one pulp mill in Uruguay, located on the bank of the river Uruguay close to Fraya Bentos. This mill produces about 1,2 million tons yearly and employs around 200 persons. Also here the location of the mill is convenient for transportation, since the mill is just a few hundred meters from the quay. (Eluen, I. 10 Oct 2013a.)

3.2 Ports

In this thesis, five key ports can be identified. Two of these ports are in Finland, one in Germany, one in the Netherlands and one in Uruguay. Besides location, these ports can also be divided in two categories by function: feeder ports and ocean ports.
It is also worth to note Changshu as the main port of destination in the Asian market.

3.2.1 Feeder ports

In this case feeder ports are mainly used as short range transportation system that feeds pulp to other locations for long range transportation. Both of these feeder ports are in Finland, located in Pietarsaari and Kotka.
Both ports are connected to the world's oceans only through the North Sea before which vessels have to navigate through the mainly coastal waters in the Baltic Sea and in the straits Kattegat and Skagerrak. All this makes it difficult to use full-sized ocean-

going vessels, which is why these ports transport pulp with smaller vessels to the ocean ports described in the next chapter instead of going straight to the end destination. This can be viewed as a part of the materials handling theory, even though the scale and range of these feeding shippings might suggest otherwise.

3.2.2 Ocean ports

Ocean ports differ from the feeder ports not only in terms of volume and capacity but also with having access to ”open seas”. Examining UPM’s pulp, three ports handle most of the cargo, being located in Germany, the Netherlands and Uruguay.
These ports have little difference in function, the main one being that Nueva Palmira in Uruguay operates mainly as a cargo sender, in comparison to the two ports in Northern Europe which act as destinations.

As it was said, Emden in Germany and Vlissingen in the Netherlands are the main destinations. These ports take in the feeding shipments from Finland and move the bales to ocean-going vessels or land-based transportation for European destinations. These ports are also the destinations for the pulp shipments coming from Nueva Palmira. Vlissingen gets two shipments a month from Nueva Palmira and Emden one per month. (Eluen, I. 10 Oct 2013b.) Generally speaking both the Emden port and Vlissingen port can be seen as focal points in the whole pulp supply chain since most pulp goes through these locations at one point of their journey.

4 Logistic process

Pulp bales can be considered a somewhat unique/difficult product to handle since it's heavy but at the same time quite fragile to environmental and physical damage. This is why the chain of logistical processes involving pulp is best explained step by step. First we must examine the special handling equipment used in transporting pulp. Due to the nature of pulp as a product, it is handled mainly by special equipment designed not to cause damage to the bales, like for example the flatbed trailer with rollers or the clamp trucks.

4.1 Equipment

First time a special handling tool has to be used is when a bale is taken from the platform at the end of production line. There it's loaded to a special flatbed trailer with a conveyor system, which enables smooth and secure loading. With this flatbed trailer the bales can be easily transported to the warehouse or straight to the pier. The conveyor or roller system allows for maximal efficiency and eliminates an extra lifting phase that would be needed otherwise. (see attachments 1-2, the yellow trucks and trailer on the pictures.)

Once at the destination, the flatbed trailer is emptied by using forklifts with a special clamp system designed for handling pulp. These clamping "forks" usually have three clamps with the central clamp stationary and the ones on the sides able adjust different sizes units. These side clamps also apply the necessary pressure to securely lift the load. The clamping system has to have certain dimensions and surfaces not to cause unnecessary damage to the bales during handling. The usual clamp system can handle three units at a time. (see attachments 3-4.)

For the actual loading to vessels, the cranes also have to be equipped with specific systems meant for lifting the pulp units. These hooking systems can be either manual or automatic depending on the target vessel and lifting procedures.

These hooking systems are used in different configurations, usually divided by three, for example one of the bigger configurations is three rows of four bales a-side meaning 12 units in one lift. These configurations are quite varied due to different vessel types being used and also by the cranes in use. (see attachment 5 as an example of correct hooking.)

4.2 Mills

As a ready pulp bale comes out from the production line, depending of the destination, the next thing is to have the bale wrapped. The bales are wrapped with an extra outer sheet of pulp. This is mostly done to prevent any impurities reaching the pulp, especially for customers producing special papers where the quality of the pulp is paramount.

Whether wrapped or not, next the bale goes through the wiring machine, which binds the bale with steel wires. Typically the pulp going to export is stacked in bigger units that are then bound with 6-7 wires, both wrapped and unwrapped, since experiences have showed that the lifting process in the ports requires more wire strength. If going to domestic/local use, the bales can just be bound by 2-4 wires, since there's no lifting and the bales are stacked in smaller units anyway.

After this the bales are lead with a conveyor belt to the loading platform, where they can be loaded to a special truck bed with a conveyor system enabling a smooth loading. This cargo unit can then be towed/driven to the storage facilities, or sometimes like for example in Pietarsaari straight to short-term warehousing at the pier. In other locations this might not be possible due to for example the harbor's size. (Fagerudd, S. 2013.) Below is a process diagram further explaining the operations in Pietarsaari.

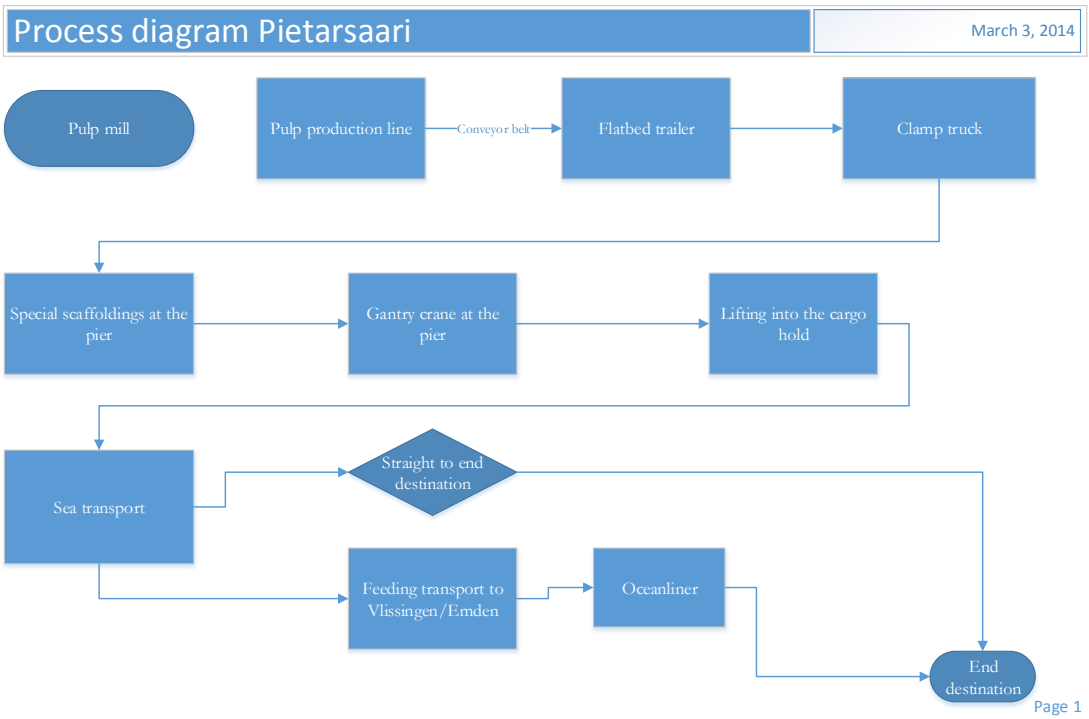


Figure 1. Process diagram Pietarsaari

Of course not all UPM's pulp mills are at the coast, so those facilities use a land-based transport at this point to get the products to the harbor. The processes used in this case don't differ that much from earlier. Now the special truck bed is just towed to a similar platform but alongside train tracks, where the bales can be forklifted on the train carriages. If there's no rail connection available, then the conveyor at the "production end" can be used to load long-distance trucks for road transportation.

At this point, in most cases, the responsibility for handling the product transfers from the mill warehousing staff to port operators. Of course there's differences between different locations due to size and other factors, but basically this is the way the process moves forward.

4.3 Ports

The logistical operations in this stage of the supply chain can vary a bit, depending on the size of the port for example. At this point most of the work on the bales is done by independent port operators.

4.4 ”Free” bales

The first phase when loading “free” units into a vessel’s cargo hold is to set up special supports/scaffoldings/platforms to protect the bales from contact with the pier. These support structures protect the bales from contamination during the loading.
The bales are then transported from the warehouse to these platforms using the special handling equipment mentioned before, from where it can be lifted on the vessel either by using cranes at the pier or, especially with bigger ships, their own cranes. (see attachments 1-2.)

The actual lifting is done using the steel wires fitted earlier and a purpose-built hooking system. (see attachment 5.) Given the weight of the pulp unit this is a particularly critical phase, since any mistakes could cause significant damage and/or injury. Most of the times the lifting is done in units of 2 or 3 x 4 bales, so lifting 8 or 12 units on one go. This all depends on the facilities, hooking systems and cranes in use. Like mentioned earlier, the big ocean-going vessels can’t usually be reached by cranes on the pier, so they have built-in crane systems enabling loading using the same setup on the pier.
As it was mentioned before, the hooking process varies by the equipment used and can be done manually or automatically. There’s also a number of different configurations that are being used.

4.5 Containers

With containers, there’s no need for any special setup. The same flatbed trailer is used. It’s loaded full at the warehouse and then used as a platform for loading the container on-site at the port. This is done by the same forklifts that handle the bales at every stage. The bales can be driven and pushed to the container by the forklift, although this

has to be done with care to avoid damages. The containers can be loaded just two units at a time instead of the normal three. A normal sized container can be loaded with 13 units.
With containers the loading process at the quay is a bit simpler. The ocean-going container vessels are being loaded using the standardized methods used with any other cargo packed in containers.

4.6 Fraya Bentos to Nuevo Palmira

The situation in Uruguay differs a little, since there it is necessary to have an extra phase of handling. There the ready bales are transported (using the same equipment mentioned before) basically instantly to river barges. Here at the pier there's no need to use forklifts, the flatbeds are designed so that the crane can lift the bales directly.
These river barges can carry approximately a day's production at a time. The barge takes 8 hours for the trip about 100 kilometres down the river to reach the deep-sea harbor of Nuevo Palmira.

This setup requires a little extra from a logistical point of view as the available equipment and production/storage capacity has to be managed to ensure smooth operation. Currently the mill itself has only an "emergency" storage capacity of 5500 tons when the daily production is around 3000-3500 tons. As mentioned earlier a barge can hold a day's production and since the trip takes 8 hours and loading the barge also takes significant time, there's a need for continuous management to ensure unstopped operation. This is why there's three barges and also one on reserve to avoid any costly bottleneck at this point of the whole supply chain. (Eluen, I. 10 Oct 2013c.) Below is a process diagram further explaining the operations in Uruguay.

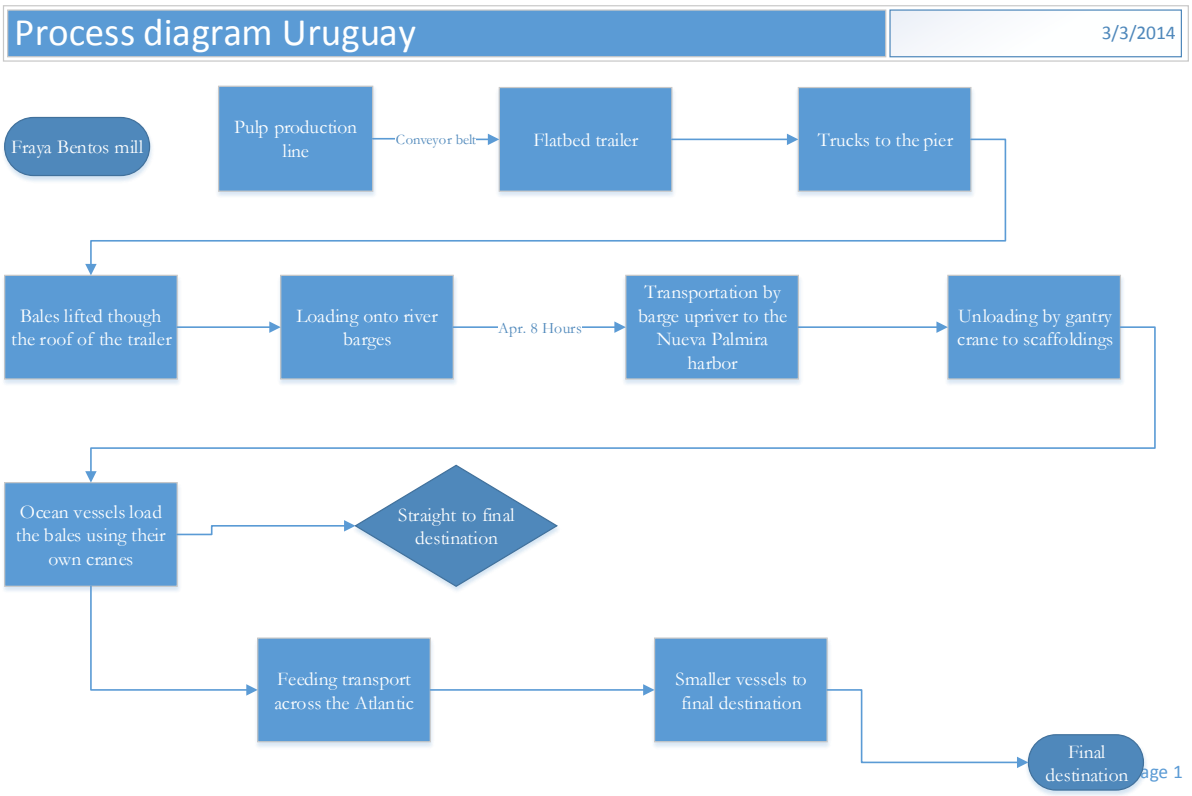


Figure 2. Process diagram Uruguay

5 Damage statistics

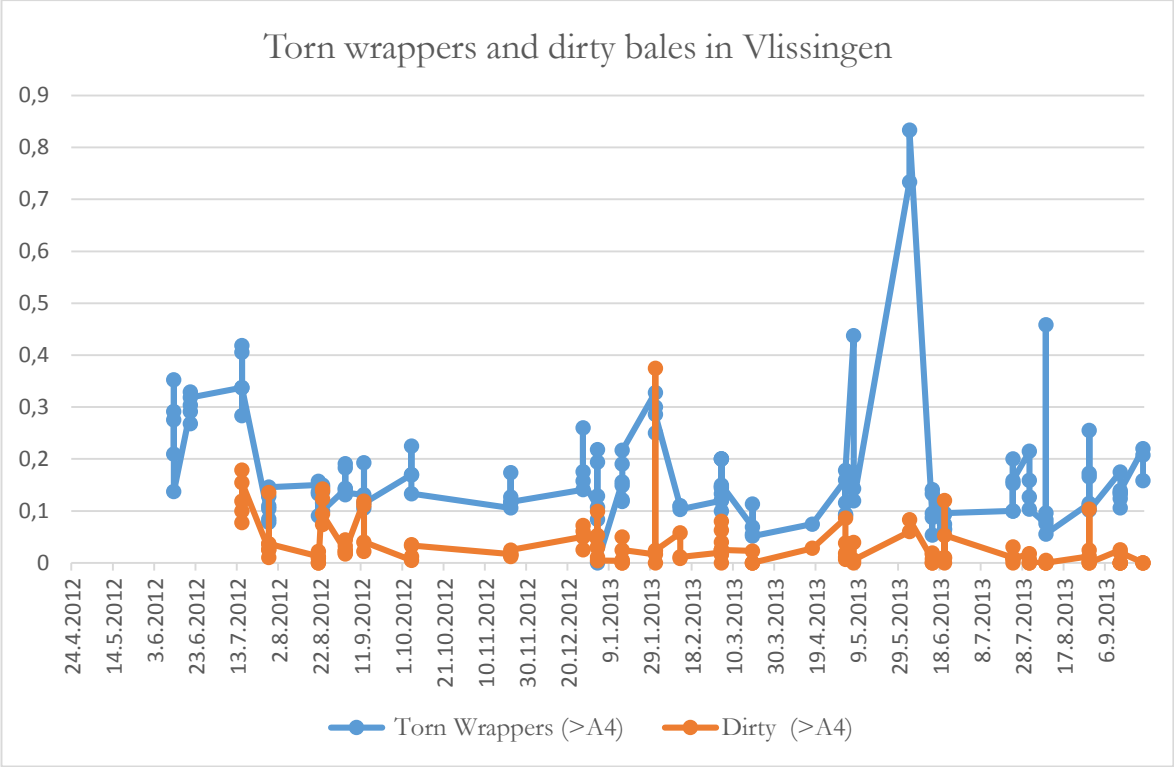
The damage found in UPM's pulp bales can be roughly divided in two categories: environmental and physical damage. Environmental damage means bales that are either wet or dirty, whereas physical damage means most of the time broken wires or torn wrappers. Both types of damage cause significant loss of value, in some cases as high as about 40-50 %.

Naturally the amount of any kind of damage to the bales varies heavily depending on location and other factors. This is why these statistics are being presented as specifically as possible to have the best idea where the biggest problems are.
Generally the amount seems to be about 10 % on average. Naturally even an average damage rate of 10 % is something unwanted and gives cause for further analysis.

5.1 Vlissingen

Handling both feeding shipments from Finland as well as receiving shipments from Uruguay, Vlissingen has a fair amount of volume and therefore it can be expected that there is at least some amount of damage. Still with this is mind, I was quite surprised by the extraordinary number of wrapper damages happening in Vlissingen during the period of examination which was between April 2012 and September 2013. Also surprising was the fact that this didn't really seem to affect the number of dirty bales, which would have been pretty easy to assume.

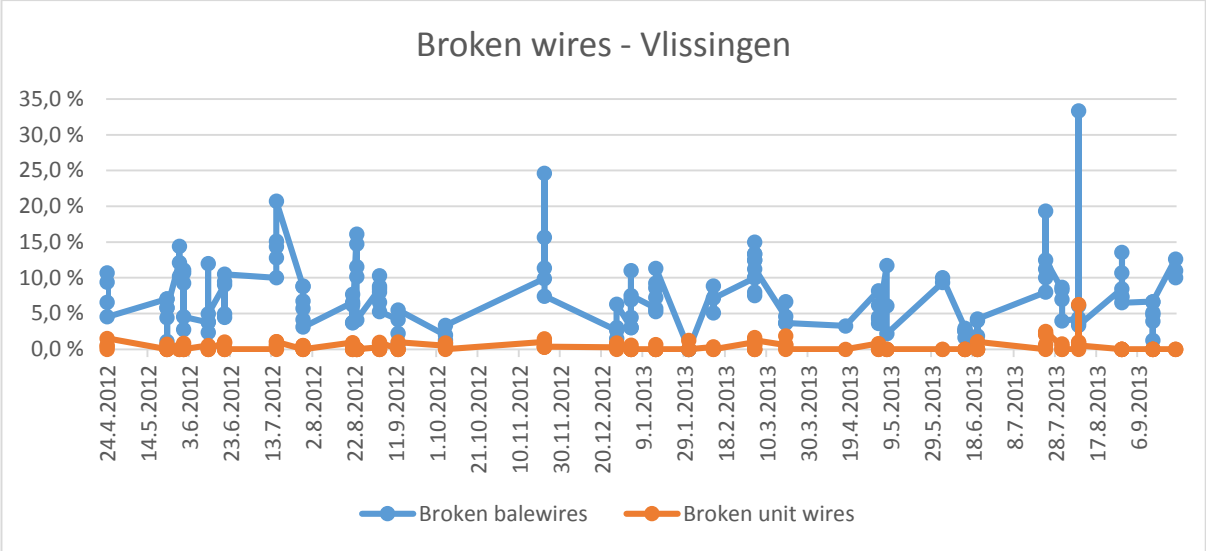
Table 1. Torn wrappers and dirty bales in Vlissingen (Eluen, I. 10 Oct 2013d.)



As the table shows, the percentage of torn wrappers seems unacceptably high, with highest amount being over 80 percent of a certain shipment. There is also several shipments with an over 40 percent damage rate. The average percentage of torn wrappers over the whole examination period is 17 percent, meaning almost a sixth of the total pulp cargo was affected by damaged wrappers.

The total amount of cargo examined during this period was over 30000 units, with almost 8000 units having sustained some kind of damage. Of those 8000 units, about 5500 units were affected by the damage types shown in the chart above.
For some reason the high number of torn wrappers hasn't really affected or increased the number of dirty bales, which as we can see in table 2, has remained relatively low.

Table 2: Broken bale and unit wires in Vlissingen (Eluen, I. 10 Oct 2013e.)



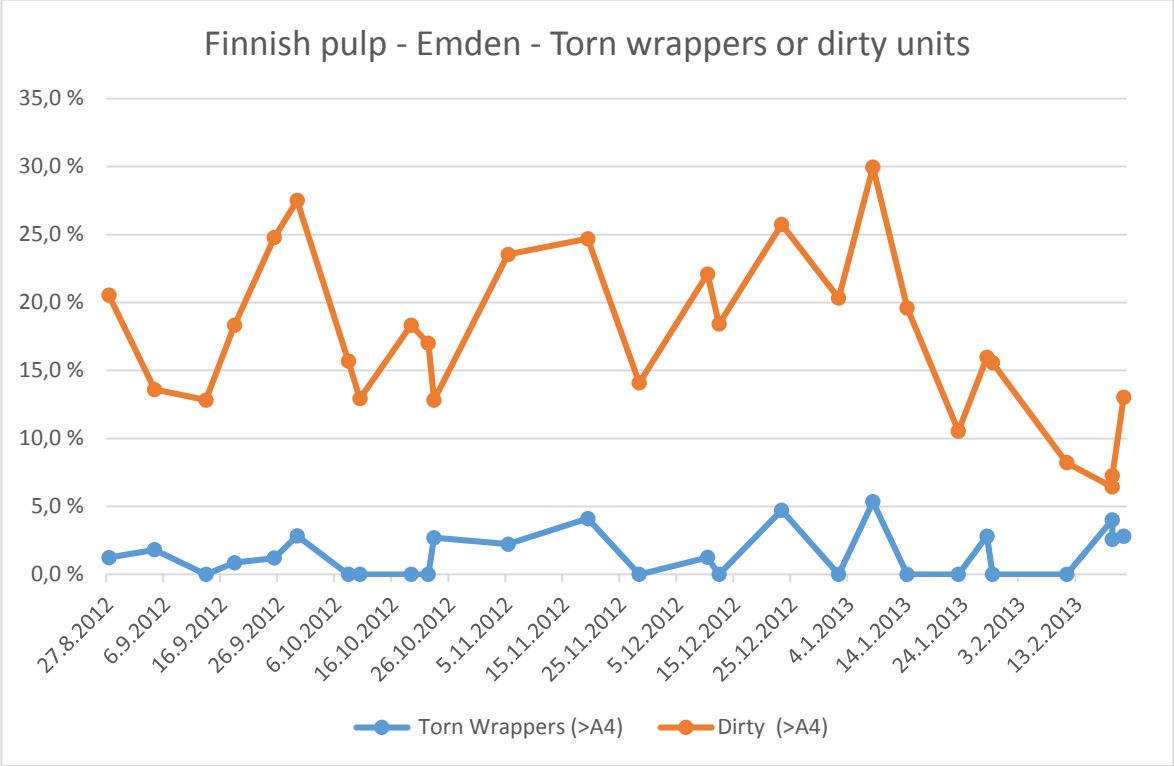
As table 2 shows also the amount of broken balewires is considerably high, peaking at over 30 percent of a shipment. Overall the amount is relatively high averaging a little over 7 percent during the examination period.

As showed in the tables, broken unit wires and unit dirtiness has not been a significant problem in Vlissingen during the examination period. Then again the high percentages on both broken balewires and especially wrapper damage is cause for concern. Even though at least the torn wrappers are not considered to be a severe damage category, it is still very alarming to have this much problems with them. After all it exposes the pulp to environmental factors such as moisture and impurities. Luckily in this case this has been avoided.

5.2 Emden

The statistics about Emden are divided similarly as before by the two related damage types. They are also divided by origin to Finnish pulp and Uruguayan pulp. These statistics use a different examination period from August 2012 to February 2013.

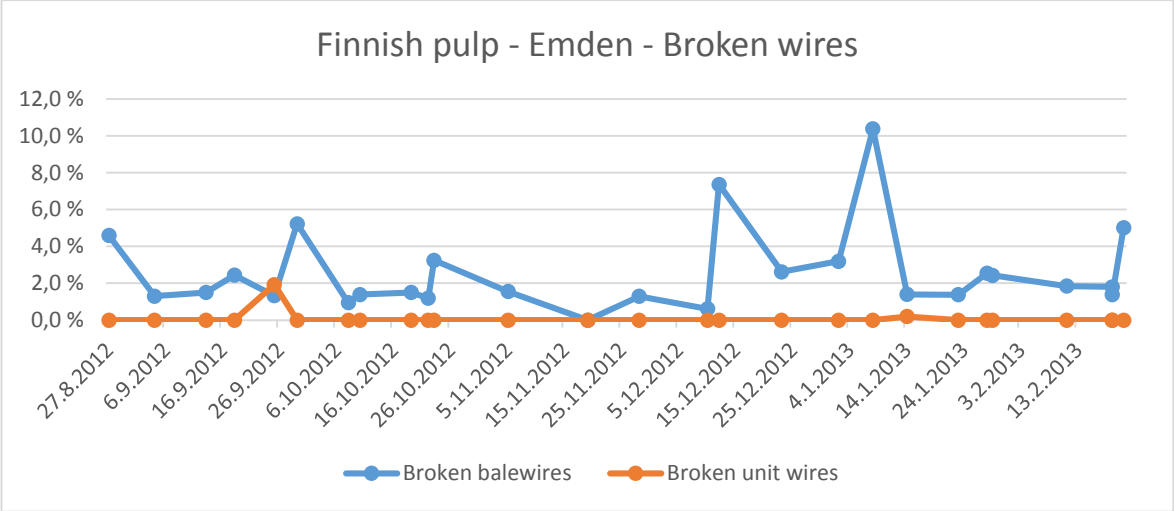
Table 3. Finnish pulp in Emden, torn wrappers or dirty units (Eluen, I. 10 Oct 2013f.)



Interestingly the table shows that Emden has a situation similar to Vlissingen when looking at the Finnish pulp shipments. Only here the situation is vice-versa, the wrappers are generally in a good condition but there is a high number of dirty units. As I already stated earlier, these two categories would logically affect each other but clearly the material shows otherwise.

In Emden the percentage of dirty units peaks at 30 percent and goes over 20 percent several times. The average rate of dirtiness for the whole period is over 17 percent. As it was in the case of Vlissingen, this is clearly way too high a number, especially since impurities in the pulp have a strong effect on the sales value of the bale.

Table 4. Finnish pulp in Emden, broken balewires or unit wires (Eluen, I. 10 Oct 2013g.)



In the case of broken wires Emden does better than Vlissingen. Even though the damage rate peaks at 10 percent for balewires, the overall situation is still acceptable regarding Finnish pulp. The average rate for the whole examination period is a little over 2 percent, a level I feel is very good.

Table 5. Uruguayan pulp in Emden (Eluen, I. 10 Oct 2013h.)

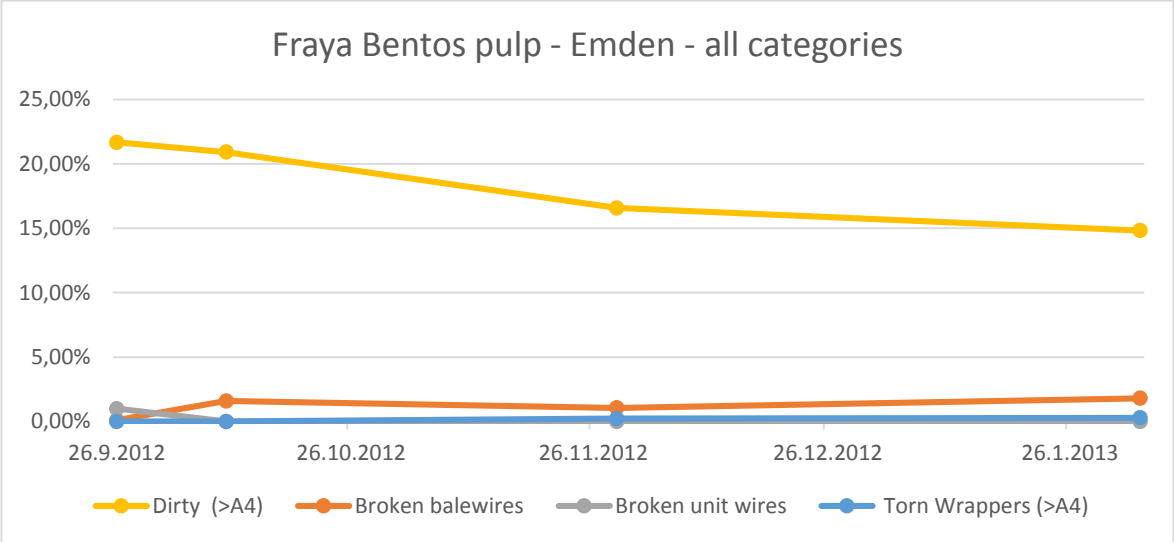


Table 5 shows the same kind of trend as tables 3 and 4. Number of dirty units is similarly high as with the Finnish pulp. Again the damage rate peaks at a relatively high 21 percent and also the average for the whole period is high at 18 percent. If we were only looking at this table, the problem with dirty units probably would not be as concerning, taking account a very limited sample of shipments. However examining tables 3-5 we

can see a clear trend, which shows that a large number of damage is happening to the pulp

Overall Emden examined over 95 000 units of cargo, of which 19 974 were affected by any kind of damage. As the tables showed, dirty units was clearly the biggest problem in Emden with over 16 500 units or 84 percent of cargo having been affected.

5.3 Changshu

As a main destination port for the Asian market Changshu handles quite high volumes of cargo, therefore it should be included in the examination. Here the examination period used was between January 2012 and October 2013. Also the handling procedures are a bit different due to the ports location and qualities. (Sundström, F. Aug 2013.)

Table 6. Changshu pulp, torn dirty or serious (Mirande, R. 1 Nov 2013a.)

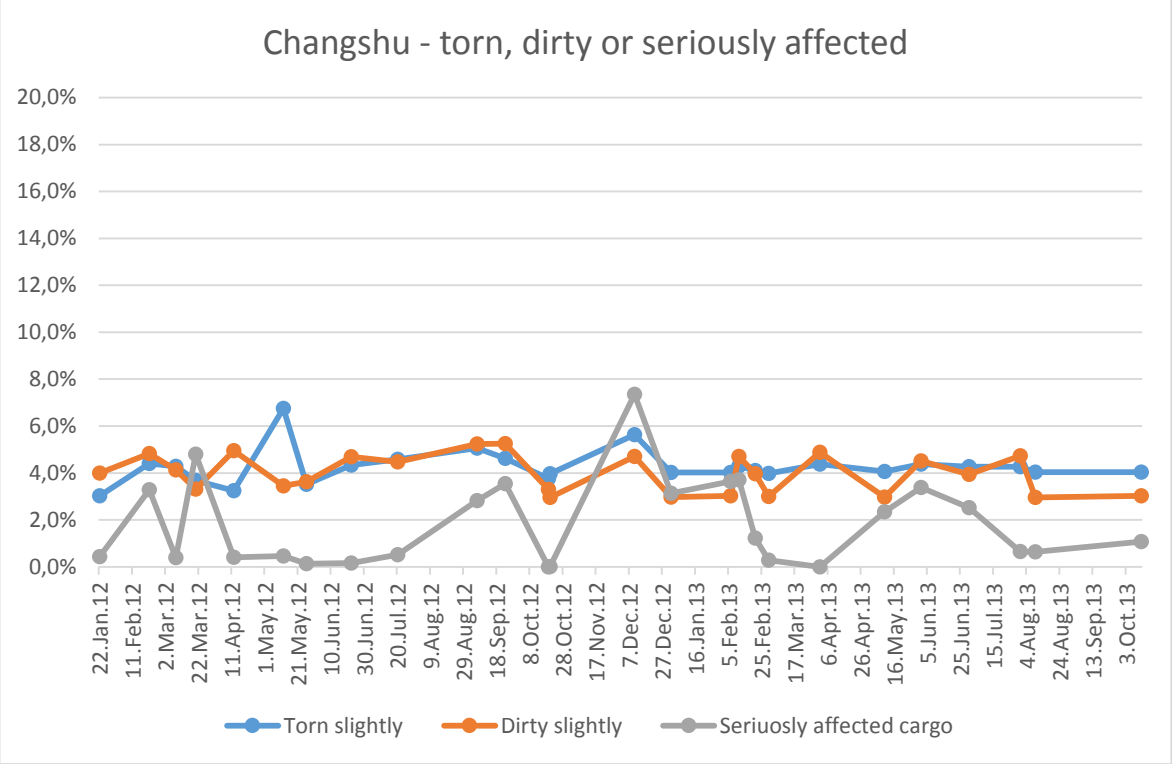


Table 6 shows a seemingly positive trend in Changshu port operations. Overall damage levels are not as high as in the European ports. The most important category here is naturally the seriously affected cargo. The levels in this category are quite acceptable,

since the level is steadily around 2-3 percent, with only two values over 4 percent and one over 6 percent.

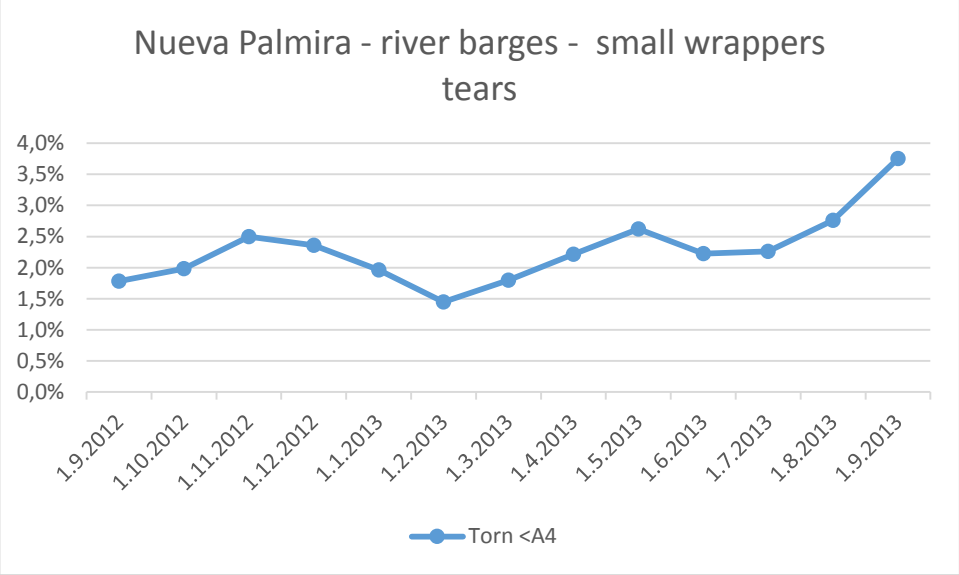
The table also shows that the levels of minor damage i.e. torn or dirty units, are also quite low and steady. Both percentages move between 3-5 percent with no really no significant peaks.

Overall Changshu handled over 320 000 units during the examination period with just over 30 000 units affected by damage, resulting in an average of 9,7 percent for the whole period.

5.4 Nueva Palmira

It is also important to examine Nueva Palmira, even though it handles a bit different traffic. The data here is examines the river barges coming from the pulp mill at Fraya Bentos to Nueva Palmira to be loaded on to ocean-going vessels. Because of this Nueva Palmira also has by far the largest volume of cargo of all the ports examined. Nueva Palmira has examined almost 1 million units of cargo in comparison to the over 95 000 and over 30 000 units of Emden and Vlissingen respectively.

Table 7. Nueva Palmira river barges (Eluen, I. 10 Oct 2013i.)



As we can see, with this type of transportation the damage level is quite negligible. Smaller than an A4 sheet sized tears are the only damage category with significant amount of results. Even these are quite nonexistent taking into account the volume of pulp being moved by these barges on a monthly basis.

6 Damage causes

Damage causes can be divided in to categories: environmental and physical damage. Of these to environmental causes are naturally the ones not always controllable due to weather or force majeure type of occurrences. Even though not always controllable, there is still always something that can be done to prevent these so called outside influences.
Physical damage on the other hand can usually be attributed to the active participants in the handling chain, i.e. people. Most of the damage thought to be in this category can be prevented, of course only up to a point where it is still sensible without using too much time, money or resources. A perfect 100 percent damage record could be probably be attainable but it would not make any sense business operations wise, since it would lead to a loss of value due to lost time and resources.

6.1 Environmental damage: moisture

Of the environmental causes, moisture is probably the simplest to understand and counteract. This is the same with most cargo I feel. After all most of the cargo worldwide is transported by sea and during this it is easy to understand that avoiding contamination by sea water is one of the first things ship operators and logistics companies have to think about. In UPM's case, this damage type has not been significant, even though it could cause loss of value to the product in the higher category all the way up to 50 percent. The overall levels of wet units across all the cargo statistics analyzed in this thesis are as low as 1 percent or less, which is an excellent level. With around 1,5 million units of cargo being transported during the examination period, only about 600 units have been reported being wet.

Naturally the most likely reasons for wet units, are exposure to weather and/or sea water. Most of the time this is due to incorrect handling aboard the vessel, or incorrect storage in the facilities at ports. Any cargo aboard a vessel is always supposed to be covered against the elements, most of the times this is achieved by having most of the cargo in cargo bays and any cargo stored outside the bay is usually covered or in con-

tainers. Of course we have to assume as well that for example containers might not always be in a perfect condition, which can easily cause moisture to get to the product. The same goes for the vessel itself and the cargo bays but this is also a safety concern for the ship, so I feel it is highly unlikely that moisture damage caused by leaks in the vessel would be a big problem. Any storage done at the ports also has to be carefully planned, so as not to have the cargo sitting in pools of water while being stored. Nor should the cargo be exposed to direct rain or snow. In addition to this, especially with pulp being a relatively absorbent material, one also has to make sure the storage areas ventilated well enough that any moisture getting inside the facility will not stay there and be absorbed by the pulp bales.

6.2 Environmental damage: dirt and contamination

Dirty units can be seen as a similar type of damage which could logically be caused by environmental causes. Based on the data, this is not necessarily the case, since both the Emden and Vlissingen cargo statistics showed high levels of dirtiness but differed strongly on the exposure of the bales i.e. torn wrappers. In this case dirtiness was one of the main problems as showed by the statistical data, especially with the port in Emden. As stated before Emden's dirtiness rates were on average almost 20 percent, when on other locations the average rates were around 5 percent. Due to this, the combined amount of dirty units across all locations was around 41 000 units from the approximate total amount of 1,5 million units of cargo. While this does not seem such a high amount compared to all the cargo, it is still unnecessarily high.

Dirtiness can be caused by a myriad of reasons, varying from environmental to physical reasons. Here even more than before, the key is the correct handling of the pulp. Pulp is highly susceptible to contamination by dirt, grease, plastic, rubber etc. This is why great care has to be taken when planning how and where to store it. All the storage areas have to be kept clean of any debris on the floors and the bales have to be stacked on a preferably metallic platform. One interesting problem is how to keep birds out of the storage space, which is most of the times open, since like stated earlier it has to be well ventilated. Naturally all handling equipment has to be kept clean of any

contaminants as well and maintained so often as to not have any leaks of lubrications or oils for example.

As well as all the operations and spaces around the port have to be clean enough to not contaminate the product, the vessel are also a key point in keeping the pulp clean. The cargo bays have to be cleaned many times before loading, since obviously transport various types of cargo, which can be very harmful to each other. Besides this care has to be taken with covering the cargo areas with tarps or similar things to avoid unnecessary contact with the vessels surfaces. This is a simple solution and is always faster and easier compared to having to spend a ton of time and effort in keeping the cargo areas absolutely dirtless.

Getting units dirty cannot always be avoided though, since one of the most likely reasons for it is friction. By this I mean the way the bales are stacked in the cargo areas of a ship. The bales cannot be loaded in such a way that they are absolutely immobile, they are always going to move around a little. (Huovila, V. Sep 2013.) This is especially likely with the longer ocean crossing routes, like the voyage from Uruguay to Europe at about 26 days and to Changshu at about 55 days. (Eluen, I. 10 Oct 2013j.) Even while the cargo is of course fastened tightly already for safety's sake and different types of air bags and other buffers being used, some movement is inevitable. This movement along with the balewires can slowly chafe against the vessels bulkheads, releasing paint, rust and other material that contaminates the pulp. (see attachments 6-7.)

6.3 Physical damage

More on the physical side of damage are all types of broken or bent wires. These are mostly caused by human action. Sometimes it is possible that the wires are already wrong straight out of the wiring machine at the end of the production line but this is not really common. Wire damage is one of the more important categories, since it is basically the only one with a lot of potential for work safety hazards. Any kind of wire damage could result in injury or other accidents during lifting procedure in loading and unloading the cargo. Of course this is also the phase were the wire damage itself can

occur, if the lifting technique is not safe or the hooking procedure is not executed correctly (see attachment 8.) These two reasons are the most likely ones to cause wire damage since the handling with clamp trucks causes a lot less stress on the wires. Of course that is not to say that the clamp handling cannot damage the wires, if done incorrectly or with the wrong kind of equipment. Statistically Vlissingen seemed to have the most problems with wire damage, averaging at around 7 percent. (see attachment 9.)

Wire damage and the lifting technique mentioned are both linked to another damage cause, which is loose units. Loose units are also something of a work safety hazard, with possible results being the same with broken unit wires, which is dropping the units being lifted. Loose units also cause the most loss of value in terms of time, since handling loose units increases the handling time by a multiplier of as much as 65. Handling a loose unit has been known to make as much time as loading 60-70 units to five truck. (Mirande, R. 1 Nov 2013b.)
Loose units are also very likely to have a contributing effect on the other parts of the cargo handling. If a large number of units is loose when loading, it makes maximal space utilization even harder and costlier time and effort-wise. (see attachments 10-11.)

7 Solutions

Most of the damage causes detailed in the previous chapter can be counteracted or at least reduced by a number of means. Of course it is not always productive to try and avoid damage, since a low percentage of overall damage during any kind of business operation is to be expected. Sometimes a perfect damage record (that is to say no damage at all) is not really difficult to achieve but many times it is faster and cheaper to allow a certain level of damage so that efficiency and productivity can be held at the maximal level.

This does not mean however that damage to cargo should be taken lightly, since it always leads to some kind of depreciation either through loss of value or through loss of resources and time. For many of the damage types and causes listed previously, various methods are already in use to limit the amount of damage and those effects on the whole business operation.

7.1 Limiting exposure

As mentioned in the description of water damage, the key is limiting exposure. This done mainly by careful planning of the storage methods aboard the vessel and in the warehousing facilities at ports. All the warehousing locations have to be covered, ventilated and equipped with sufficient drainage capacity. This is usually achieved quite easily by having purpose-built storage areas for pulp or if that is not the case, doing the necessary modifications (e.g. roofing and drainage).
Aboard ships all these requirements are a bit harder to fulfill due to the realities of ship design. This is why onboard covering the cargo is the key response to avoid unnecessary water damage. This is probably also the most efficient way to load a ship anyway, filling the cargo bay first, then covering it and loading containers at the top level. Sometimes it is also necessary to drain the cargo areas before loading, since water or some other liquids could have been gathering there during previous sea transports. Even with this being done the cargo bay is covered with tarp to limit the exposure to debris or moisture.

The use of a tarp cover in the cargo bay also helps to reduce contamination of pulp by other sources than liquids. Often cleaning of the cargo bay is required before loading a delicate material like pulp. Due to time constraints this is not always possible, so it is important to use some kind of cover in either case. A simple tarp is of course not the only barrier between exposure and pulp. This is why pulp headed for production requiring higher than average quality is covered with an outer layer of protective wrapping. In other cases the solution is to load this pulp in containers, all this naturally depends on the client and sales contract used. The effectiveness of these methods might questioned in some cases. The dirtiness of units could very likely have something to do with inadequate covering options being used. I see containers as the only method that is very likely to guarantee a minimal contamination risk. As the statistics showed, the wrappers are torn in quite a large number and this should lead to more units getting dirty. Probably due to high requirements for cargo bay cleanliness and absence of debris this has not happened to such a degree I would have expected.

Due to the obvious time constraints limiting the opportunities to keep cargo bays clear of debris and clean, I would think maybe adding extra tarp cover for the pulp cargo might be beneficial. It is another thing if this is doable in real life situations with varied ship designs and loading procedures. It also might slow the loading operations too much to be a viable idea. This is mainly why I see the wire friction caused dirt coming of the bulkheads as the main problem in regards to dirty units. I cannot really see a way to prevent this since the extra tarp I mentioned probably is not strong enough to withstand the extended chafing during longer voyages. The air bag padding used stowing the cargo is the most likely solution strong enough to withstand the chafing. However I am doubtful this is doable due to ship design, space utilization and time management.

Dirtiness as well as tear damage can be managed quite easily with the correct handling equipment and techniques. This is something I was not that concerned about since the handling I have observed was done very professionally and the torn wrappers did not seem to have much effect on the amount of dirty units. The speed of handling the bales did not seem to be bothered by doing the clamping operations smartly and carefully. Of course situations are different in each locations and it is likely that in the big-

ger terminals things will be a little worse due to time constraints and overall volume. The key here is continued evaluation and quality control.
The equipment seemed well suited for the tasks and did not seem likely to cause much damage. Of course it has to be well maintained to avoid possible oil leaks or similar potential problems.

7.2 Handling

I see broken wires mainly as a result of improper handling during the hooking phase. It seems unlikely that clamp trucks would damage the wires during handling but as I mentioned before this might vary between locations. It seems that most of the major wire problems (e.g. dropping the unit) have been solved already before by increasing the number of wires. (Sundström, F. Aug 2013.) This is why I think the main reason is hooking failures and similar things. I cannot think of any mechanical improvements in the hooking and lifting itself, so it mainly comes to evaluation and quality control again. Especially in Vlissingen where the number of broken balewires was high. Standardization of the lifting process might be useful in reducing the wire damage but there probably is not many ways how to influence this due to the large variation of lifting equipment, ship designs and port operators.

Lifting should always be done by more than one hook, since that seems to cause much damage to the wires and having the units loose loses a lot of time. Some of the material I saw had quite horrible lifting techniques where the whole load is being lifted at about a 45 degree angle. This was due to using insufficient hooking and looked potentially very dangerous work safety-wise. This also created more space for the individual bales to bang against each other, which could be causing some of the tear damage. Since this is a guideline already, the problem shouldn't be not knowing the best way to lift the load but time constraints and possible indifference. Here again the main thing is to keep evaluation and quality control standards high, so that the correct procedures indicated in places such as the handling manual are being used.

8 Conclusions

Analysis of the data revealed that as a whole the level of damaged pulp is not unacceptably high. Across all the ports examined here between a time period roughly between 2012-2014 depending on location, the total number of examined cargo was almost 1,5 million units of pulp. Of those units almost 110 000 were damaged in some way, which results in a percentage of 7,6. While 110 000 damaged units seems to be a quite high level of damage, the percentage shows that in general the pulp handling and transportation is going well. 7,6 percent of cargo damage in an operation of this magnitude and with the transportation distances involved seems to be a very acceptable level. I would think that in any operation, levels like this would be perfectly acceptable, especially with the volume being this high and transportation being multifaceted and long. Even though the damage level can be thought of as low enough or acceptable, this still affect the supply chain negatively. Any bottleneck or loss of time in the supply chain will lead to loss of value as the supply chain theories suggest.

8.1 Locational trends

Naturally the average damage percentage across the board is not the whole story. When examining individual locations, the percentages get a lot higher and seems to have a clear trend in terms of the type of damage occurring. This leads one to believe there has to be some correlation with the procedures used in a certain location. The results showed a clear trend in the damage types in Emden and Vlissingen, with dirtiness and broken balewires respectively. Since these levels at these locations were much higher than at other locations, it is reasonable to believe that these two ports are not handling the pulp as well as they should be. This situation warrants further investigating to find the key problem leading to this level of damage. A closer inspection and evaluation of the processes in these ports is necessary, with these results it could be possible to prevent higher damage levels in other ports as well. On the other hand it has to be understood that time constraints and other actual operational realities might

be the cause of these problems, or make the situation such that any improvement in the damage levels would be counterproductive for economic reasons.
As I mentioned earlier, overall the handling of pulp seems to have been done in a professional and effective manner. The handling operations I observed mainly in Finland were efficient and careful enough to provide good value (the statistical material did not show any evidence which would lead me to think otherwise). This has significant effect on the overall situation of pulp handling due to the volume of pulp produced in Finland. This means 2/3 of UPM pulp at least leaves the production and initial handling phase without significant damage.

In addition to this, the last third of UPM pulp coming from Uruguay is also handled in good condition, since the damage rates are only around a few percent. It is hard to say conclusively how much of this is due to the different handling operations there, since I did not have the chance to observe the operations personally. Even so I think it is safe to assume that the river barge transportation is less prone to damage than the ocean crossing or other long range sea voyage. Besides this, the volume of handling at any location in Uruguay, be it in the mill or at the ocean terminal, is lower than in the ports in Europe.

From technical viewpoint and based on my observations there was not anything out of the ordinary with the equipment used to handle the pulp. This is why I would conclude that this probably is not causing any damage. I also did not find anything to be lacking in the monitoring or quality controlling aspects of the handling and transportation. Even so, it has to be acknowledged that sometimes time constraints might affect these measures a little bit. Still as I said overall there was not really any cause to believe this is a major factor in the process.

8.2 Personal reflections

The main purpose of this thesis assignment was to examine the supply chain of pulp bales, focusing on the handling and port operations. The goal was to create comprehensive description of the operations involving pulp bales from the production facility to transportation, in this case more specifically transportation by sea. UPM had gath-

ered information and data about pulp damage but this data was fragmented across different departments which lead to a need of a comprehensive summary and a more in-depth examination of the situation.

As mentioned earlier, the results showed an acceptable level of damaged bales, considering the volume of handling operations. Overall most of the bales are handled and transported efficiently and can be said to be undamaged, when reaching their end-user. Despite these findings, there were two ports with a much higher damage rate, limited in both cases to a quite specific external damage. These findings would suggest that there is a problem in a specific phase of the handling operations in both ports. Despite this as, I said, as a whole the pulp handling operations of UPM are executed in such a manner that they don't lead to a significant loss of value.

Examining the reliability and usability of this thesis, I would say that both are at least at a reasonable level. All the data used here can be viewed as reliable since they are either supplied by UPM as a part of their business operations or gathered by observation by the author. As for the usability, I would hope that the results are of some value and I would think that if nothing else, this thesis can be used as base or starting point for further examination of the situation.

The results show a need for further examination of the subject matter, especially for the two ports having a higher damage rate. Given that these ports are in Germany and the Netherlands, any further study would require a lot of travelling if done from Finland and therefore it would not probably be the best choice. There could also be some opportunities for related thesis projects from a technical viewpoint. In this thesis the technical and mechanical aspects of handling and loading pulp are not examined in almost any detail, given that I do not have any expertise in these fields.

During the examination period of this thesis, the logistics organization of UPM, UPM Seaways was going through an organizational restructuring. This restructuring is being done due to financial pressures as a part of the overall cost-cutting measures done by the corporation. This would be another thing to note when conducting further examination on the subject matter. The restructuring itself could be a potential target for a

thesis project and it also creates diverse effects within the whole supply chain. These changes will provide new subjects to examine and also influence the processes examined in this thesis.

As personal learning experience, I have gained a lot from this project. It has increased my understanding of the logistical supply chain and all the operations within that process. The on-site observations in various ports have given me an understanding how port logistics work in practice and have increased my interest towards the maritime industry.

Examining this project critically, I would have to say that even though I improved my time management skills, there is still some work to be done on that area. Aside from that, the thesis as a whole was a nice, interesting and successful project. I would have hoped to do even more on-site observations, especially in the European ports, to get even more detailed picture of whole situation. This unfortunately was not doable due to various problems but overall I still feel it did not have too much of a negative impact on the thesis.

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Attachments

Attachment 1. Loading setup alongside the vessel, big scale Kotka-Hamina

Attachment 2. Loading setup alongside the vessel, small scale Pietarsaari

Attachment 3. Clamp design

Attachment 4. Clamp truck

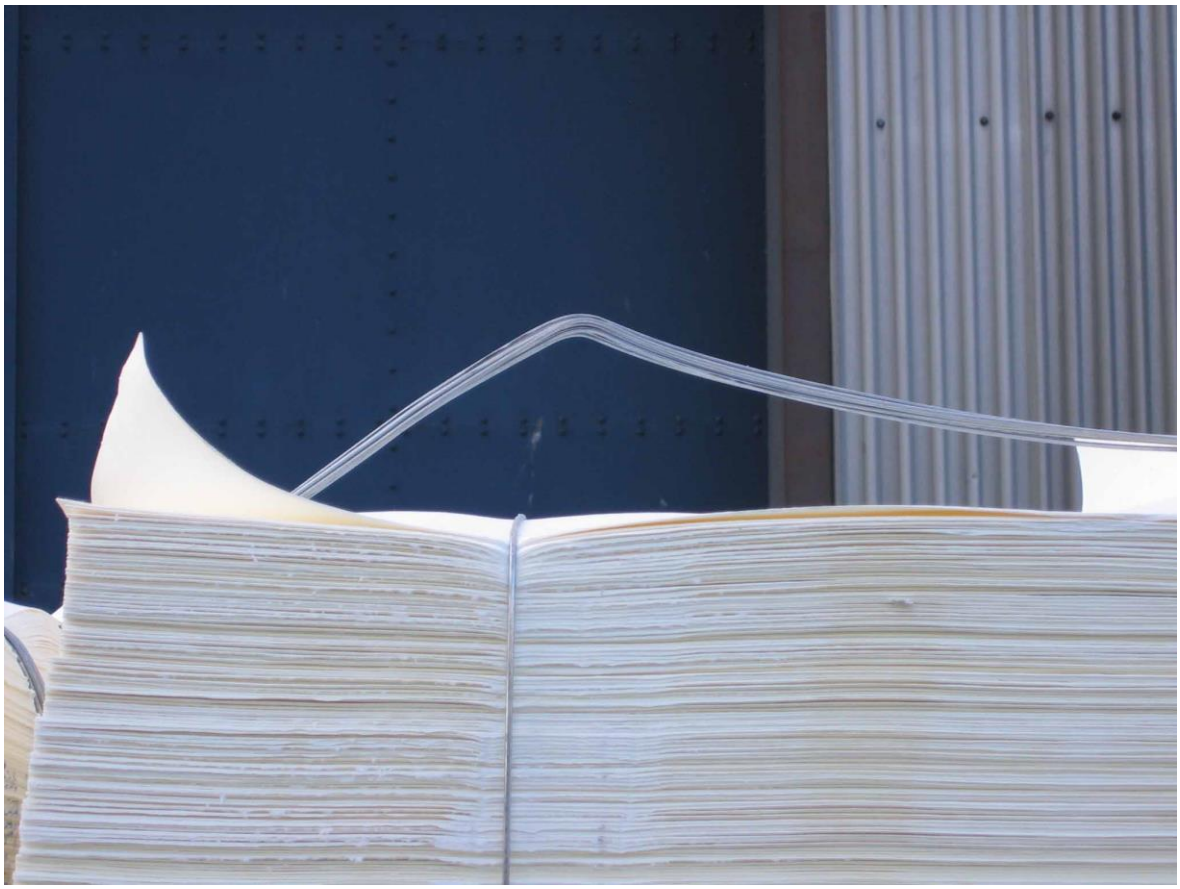
Attachment 5. Correct hooking and lifting technique

Attachment 6. Friction damage on the bulkhead of the ship

Attachment 7. Friction damage on the bulkhead of the ship, wide angle

Attachment 8. Incorrect lifting, only one hook

Attachment 9. Damaged wires



Attachment 10. Dropped unit load

Attachment 11. Recovery of loose units